



CO<sub>2</sub> Capture Project

# ***“Progress Through R&D Partnerships”***

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**2nd Annual Conference on Carbon  
Sequestration, Alexandria, Virginia  
May 5, 2003**



## Overview

- CO<sub>2</sub> Capture Project (CCP) Partnerships & Organization
- Project Screening & Progress Review
- CCP Program In Brief
- Storage, Monitoring & Verification (SMV) Program
  - SMV Team Process & Program Focus
  - Partnerships
    - Governments
    - Joint Industry Project Participants
    - Technology Providers
  - Focus Areas
  - Deployment and Communications Plans
- Summary



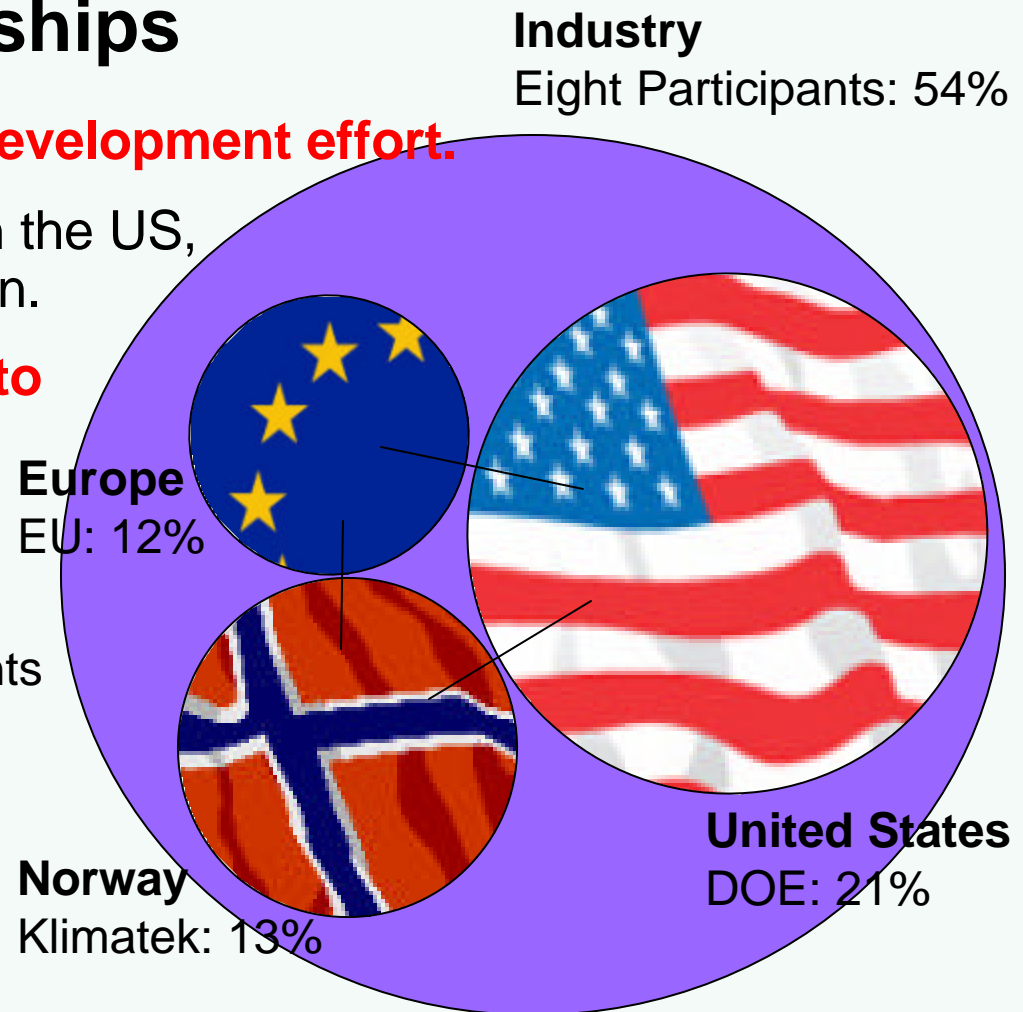
## Government Partnerships

### ➤ International technology development effort.

- Distinct *regional* programs in the US, Norway, and European Union.

### ➤ Sharing among programs to leverage results and reduce duplication.

- Project Funding \$25million
  - Total Industry & Governments





# CO<sub>2</sub> Capture Project

## Industrial & Government Partnerships



**US Department  
of Energy**



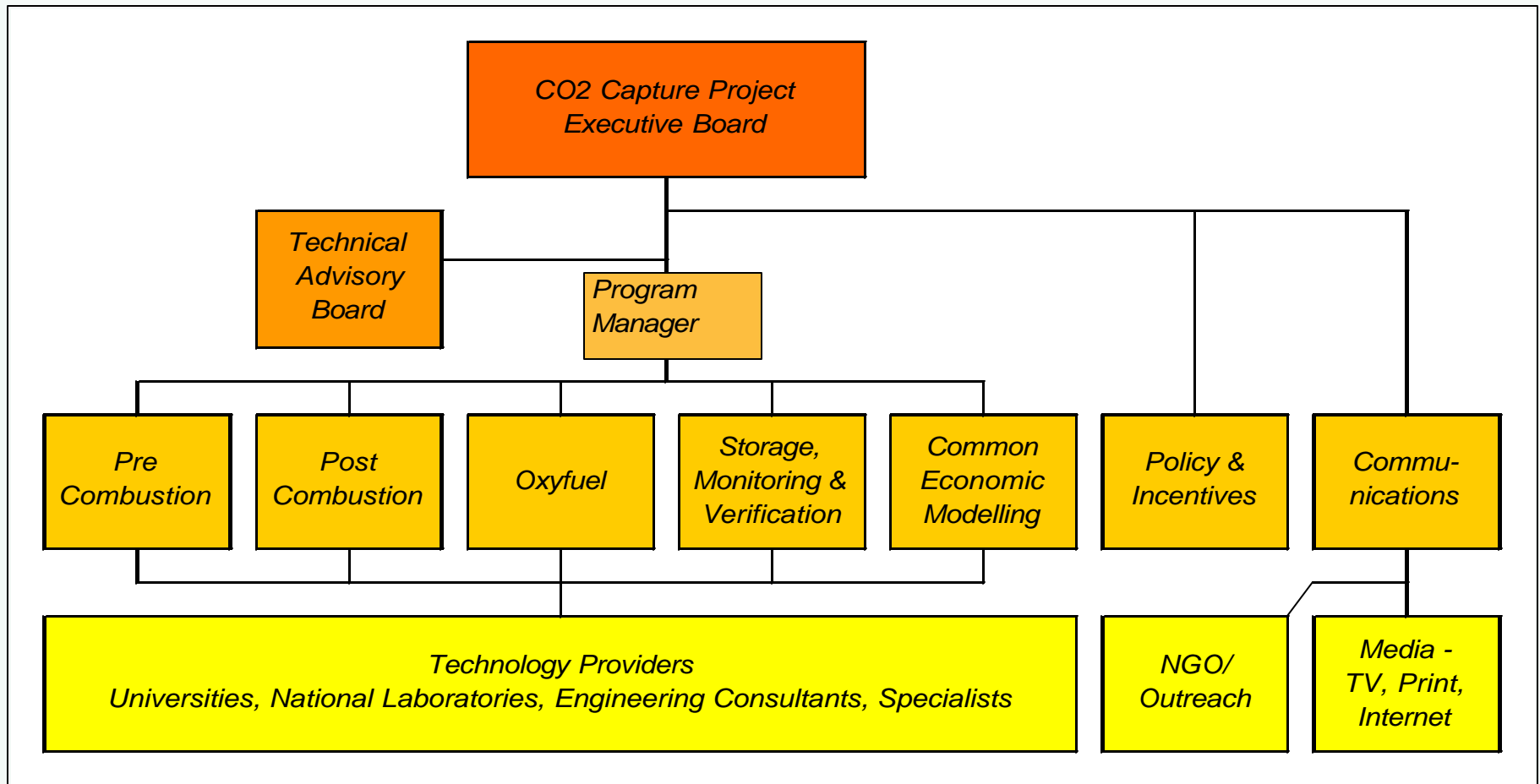
**European  
Union**



**Klimatek  
NorCap**



## JIP Organization & Governance Model



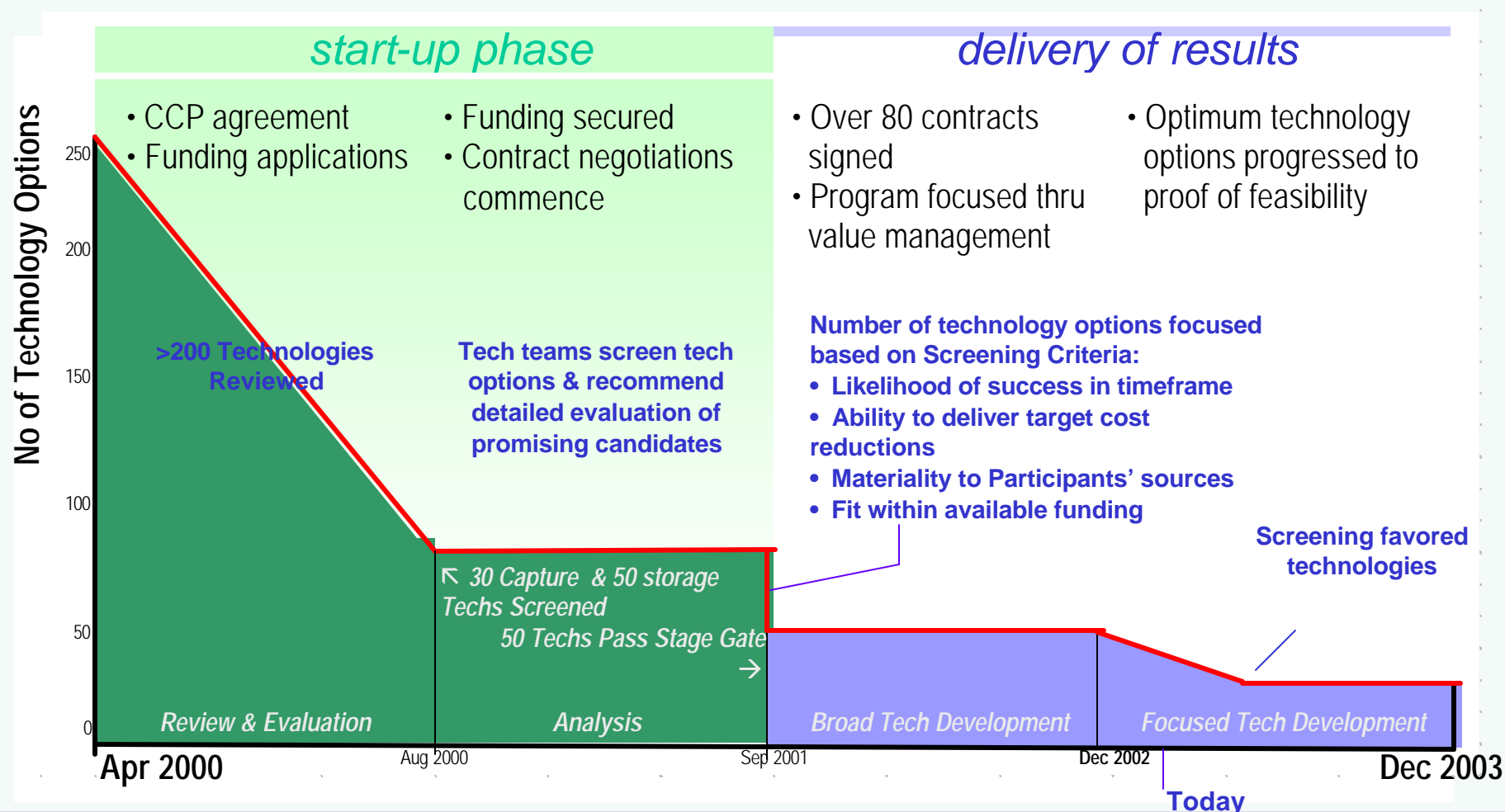


## CO<sub>2</sub> Capture Project Objectives

- Achieve major reductions in the cost of CO<sub>2</sub> Capture and Storage:
  - 50% reduction when applied to a retrofit application.
  - 75% reduction when applied to a new build application.
- **Demonstrate to external stakeholders that CO<sub>2</sub> storage is safe and effective, measurable, and verifiable.**
- Progress technologies to:
  - 'Proof of concept' stage by 2003/4.



## Project Overview- We've Come a Long Way!





# CO<sub>2</sub> Capture Project

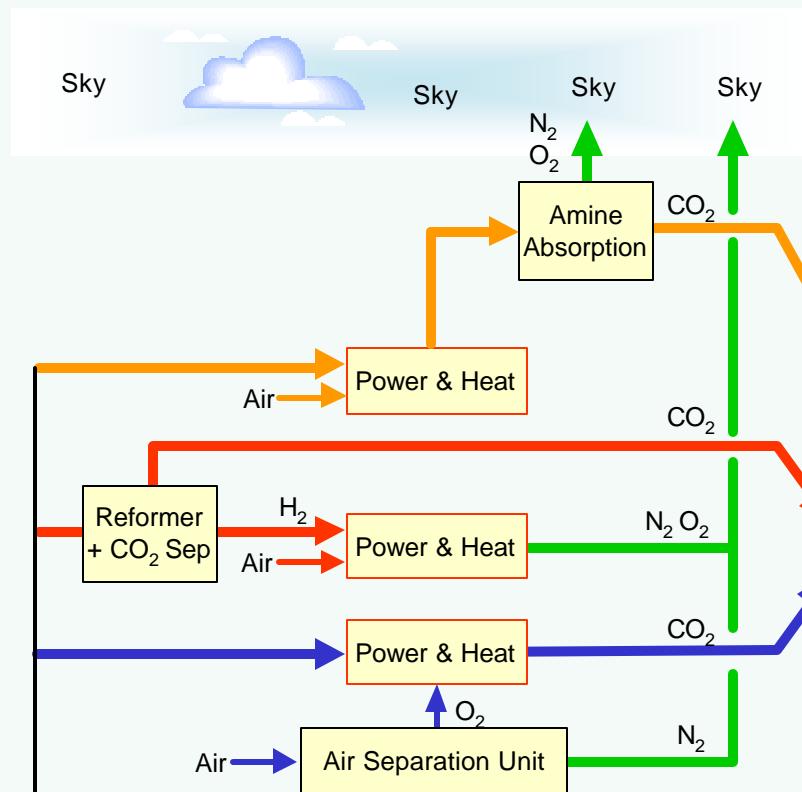
## Capture:

Post Combustion  
Decarbonisation

Precombustion  
Decarbonisation

Oxyfuel

Fossil Fuel



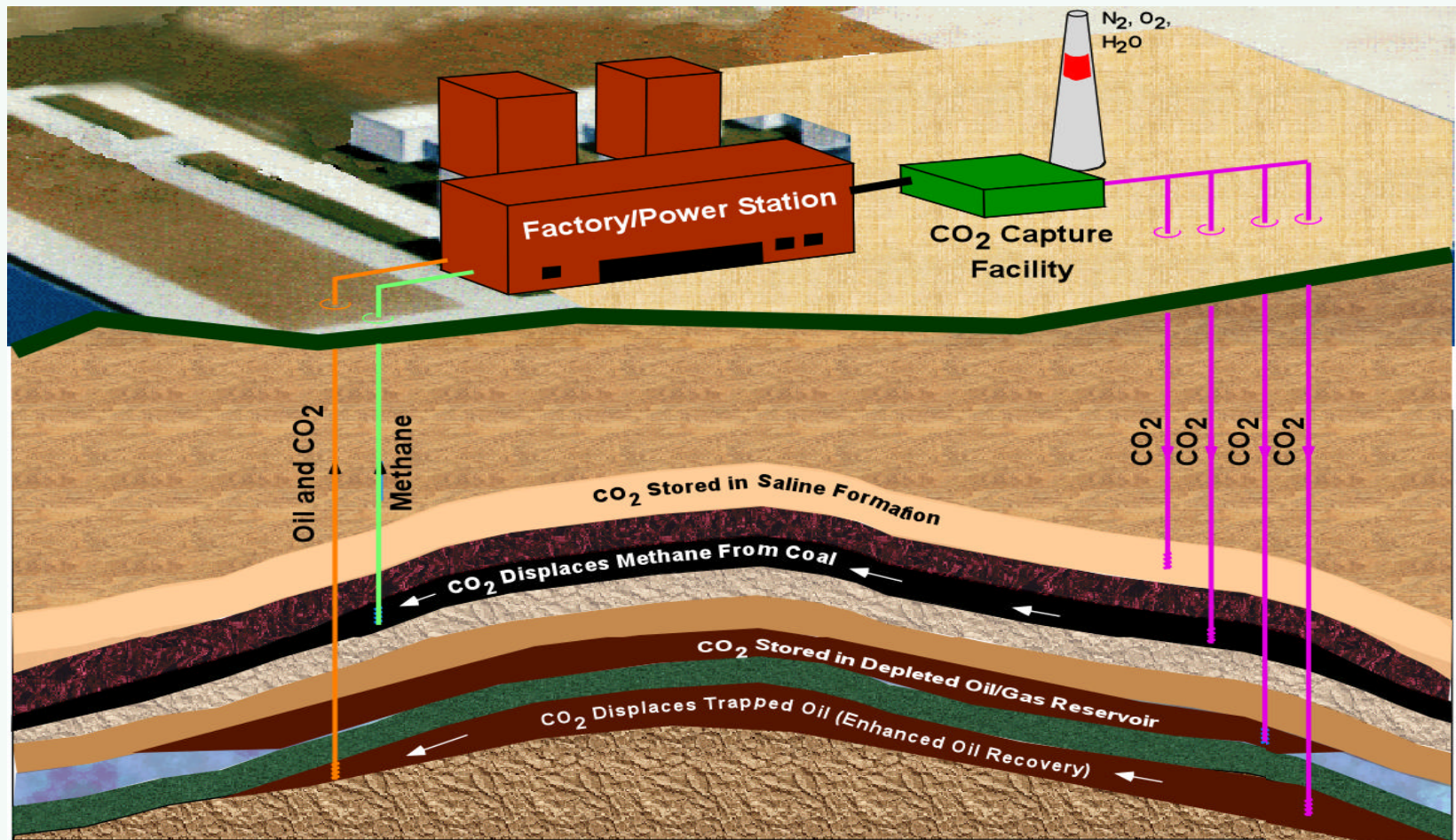
## Storage:

- Enhanced Oil Recovery
- Enhanced Coal Bed Methane
- Old Oil/Gas Fields
- Saline Formations

## R&D Focus Areas



## Storage Technology





## SMV Process and Program Focus Areas

- 1Q/2000 Formed SMV Team
- 2-3Q 2000 Reviewed DOE Roadmap, *Looked for R&D Gaps for SMV to Focus On (next slide)*
- 4Q 2000 Workshop with Technology Providers, DC
- 1Q 2001 Reviewed and Ranked 70 Proposals, and Obtained Board Approval to Proceed with 29 Projects
- 2Q-4Q 2001 Executed Contracts, Work Began, and Held 2<sup>nd</sup> Workshop in Potsdam
- 3Q 2002 Reports Begin to Be Posted on Website; Held 3<sup>rd</sup> Workshop in Santa Cruz, California



## Storage, Monitoring & Verification Focus Areas

- Understanding Geologic Storage (Integrity)
  - Natural CO<sub>2</sub> Accumulations & Natural Gas Storage Analogs
  - Reservoir, Caprock, Faults & Well Competence
- Maximizing Storage Efficiency (Optimization)
  - Storage Efficiency / Volume of Rock
  - Transportation, Materials Selection, CO<sub>2</sub> Impurities
- Verification & Monitoring (Monitoring)
  - Does CO<sub>2</sub> migrate? Under what conditions?
  - Can we verify the amounts injected?
  - What tools are appropriate for leak detection?
- Health, Safety & Environmental Risk (HSE RA)
  - HES Risk Assessment Methodology
  - HES Risk Mitigation
  - HES Risk Remediation
- *Last 2 Bullets Are Major Focus Areas for the SMV Team*



## Integrity

The 7 Integrity Projects Endeavor to:

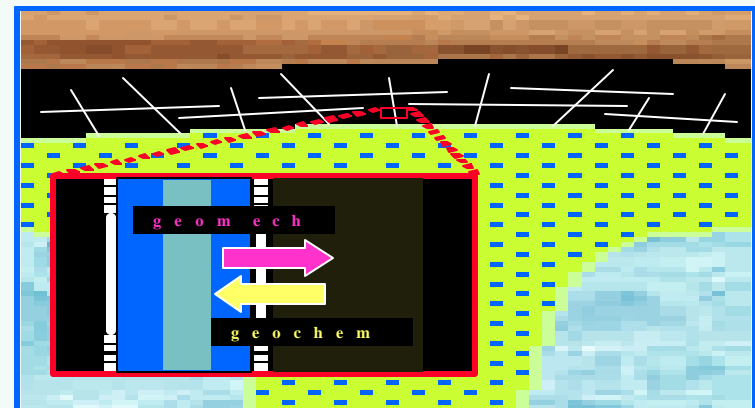
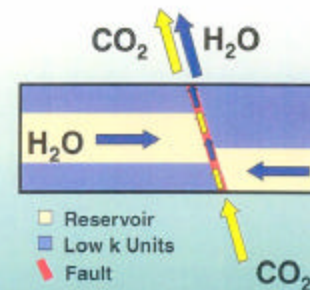
- Characterize Natural CO<sub>2</sub> Reservoirs (Competent & Leaky)
- Leverage Experience of the Natural Gas Storage Industry
- Assess the Competency of Reservoir, Cap Rock & Well Materials Exposed to CO<sub>2</sub>
- Detect Induced Microseismicity from CO<sub>2</sub> Injection

### Contracted Studies

- Borm (GFZ) – CO<sub>2</sub> & Rock Physical Properties
- Evans (USU) – Leaky Reservoirs
- Johnson (LLNL) – Reactive Transport Modeling
- Lindeberg (SINTEF) – Well Sealing Capacity
- Perry (GTI) – Natural Gas Storage
- Rigg (APRCRC) – Micro-seismicity
- Stevens (ARI) – Competent Reservoirs

### Reservoir Leakage

Crystal Geyser at the Little Grand Wash Fault





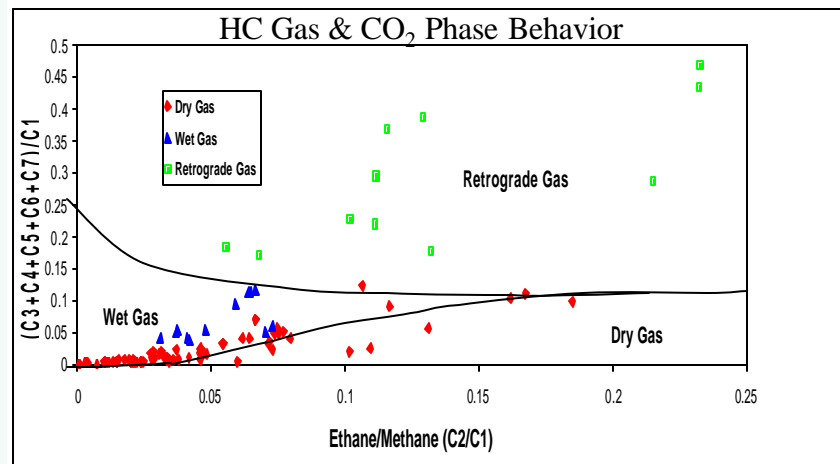
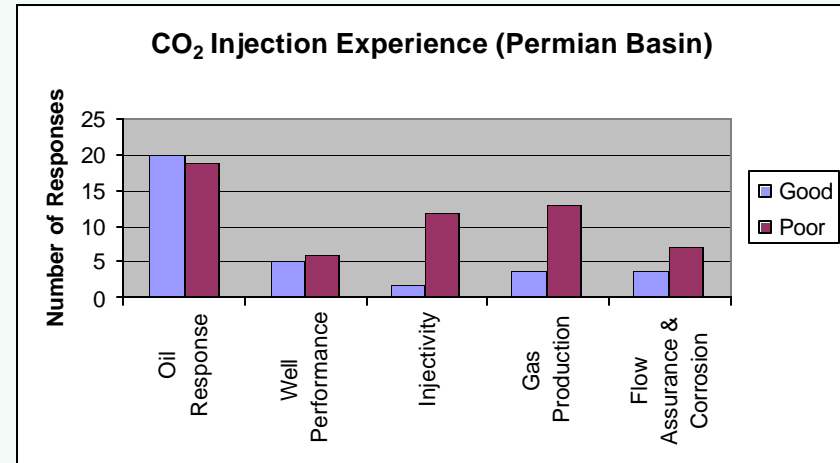
## Optimization

The 7 optimization projects aim to:

- Address Transportation & Materials Selection
- Evaluate CO<sub>2</sub> Enhanced Oil, Gas-Condensate and Coalbed Methane Recovery
- Document Acid Gas Disposal Projects
- Examine “CO<sub>2</sub> Purity Tradeoffs”

### Contracted Studies:

- Bachu (AEUB) – Acid Gas Disposal
- Frailey (TTU) – Gas-Condensates
- Grigg (MNT) – EOR
- Liang (INEL) – Coal
- Heggum (Reinertsen) – Transportation
- Seiersten (IFE) – Materials Selection
- TBD – Purity Tradeoff





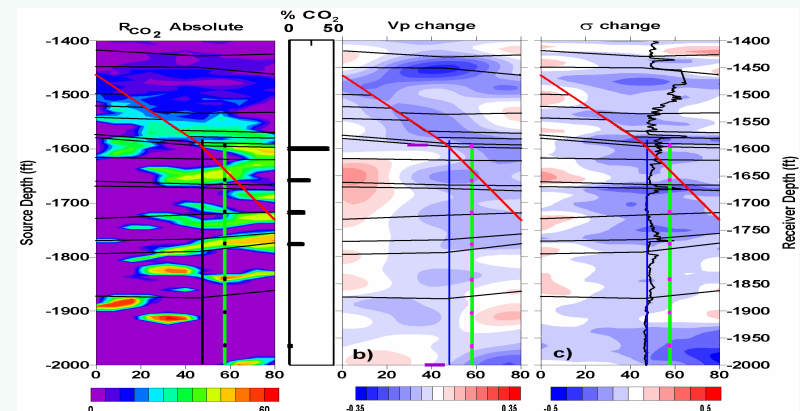
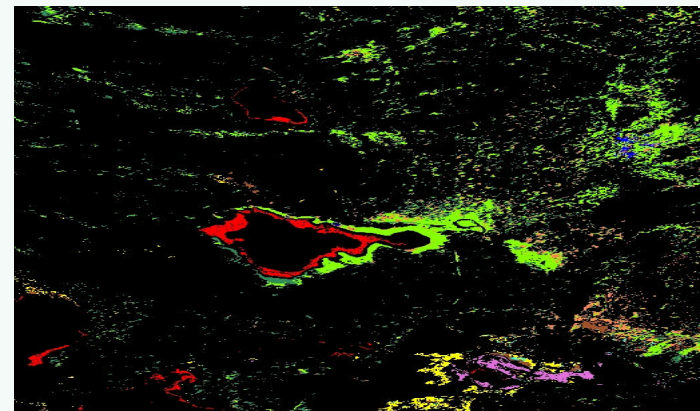
## Monitoring

### 7 Projects Approach Monitoring of CO<sub>2</sub> Storage:

- Remote Detection (Satellite & Aerial)
- Near Surface Detection (Chemical)
- Subsurface Detection (Geophysical)

### Contracted Studies:

- Arts (TNO) – Geophysical (Seismic)
- Davis (PSU) – IR Detection Systems
- Hoversten (LBNL) – Geophysical (Non-Seismic)
- Nimz (LLNL) – Noble Gases
- Pickles (LLNL) – Geobotanical Hyperspectral
- Zebkar (Stanford) – Satellite Radar Interferometry



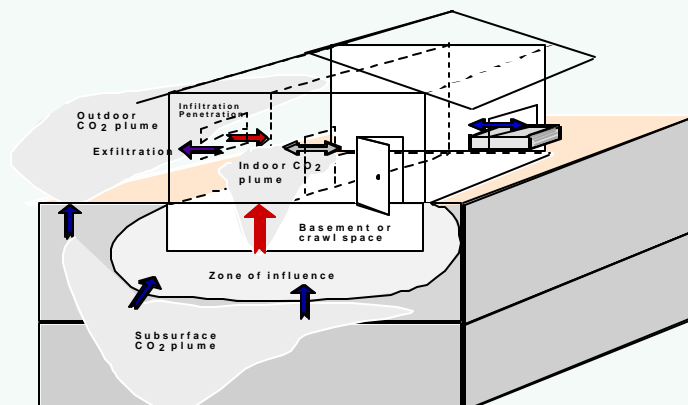


## Risk Analysis – Health, Safety & Environment (RA HSE)

### Multiple Approaches to Quantifying Risk Associated with CO<sub>2</sub> Storage:

- Early Warning & Remediation
- Environmental Impact (Terrestrial, Marine & Subsurface)
- FEP (Features, Events & Processes)
- Probabilistic & Deterministic Models
- Case Studies
  - a. Offshore, Onshore
  - b. Gas, Oil & Coal Reservoirs
- Contracted Studies
  - Benson (LBNL) – Environmental Impact (Surface)
  - Liang (INEL) - RA Methodology (ECBM)
  - Oldenburg (LBNL) – RA Methodology (Near Surface)
  - Wildenberg (TNO) – RA Methodology (Subsurface)
  - TBD – Environmental Impact (Marine & Subsurface)

Compartment	Mechanical processes	Hydraulic processes	Physico-chemical processes	Marine hydraulic processes	Atmospheric physical processes
Storage reservoir					
Seal	DIANA	SIMED DIANA	TAFFETAS/ MARTHE		
Overburden					
Shallow aquifer/soil			STOMP		
Hydrosphere (sea)				DELFT3D	
Atmosphere					PLUME+/ LOTOSUAM





## SMV Communications Way Forward

- Have engaged professional communications consultants
- We don't want to have 29 studies "sitting on the shelf"
- Rather, we want an *integrated series of reports* that attempt to tell a compelling story that:
  - CO<sub>2</sub> storage can be safe and effective
  - CO<sub>2</sub> can be monitored both short and long-term
  - CO<sub>2</sub> storage is verifiable



## Summary - ***Progress Through Partnerships***

- Formed High-Performance SMV Team
  - 8 industrial partnerships and strong partnering
  - Has grown from 7 to 15 people from 8 companies
- CCP / Government Partnerships (DOE, EU, Klimatek)
  - International technology development effort
  - Sharing among programs to leverage results and reduce duplication
- CCP / Technology Provider Relationships
  - Annual sharing and workshops
  - Monthly progress reports and occasional meetings
- For More Detailed Technology Descriptions, please:
  - **See Scott Imbus's Poster Session**
    - ***Group 1, Case Studies, May 6, Noon end of the day***
  - **Visit the appropriate CCP's PI's poster(s)**
  - ***Visit the CCP's website: [Co2captureproject.org](http://Co2captureproject.org)***



## Communications, cont.

- We plan to engage a professional association and journal
  - Extensive peer-review world-wide
- Current vision is for ~4 key audiences e.g.
  - Scientific Journal, highly technical (200-500 pages)
  - Government Report and Road Show (10-100 pages)
  - Public reader-friendly version with glossy pictures (3-10 pages)
  - TV documentaries for BBC, Nova, or Discovery Channel
- Consultant's work proposals in hand
- Deployed NLT 1Q 2004



## Acknowledgements

- Government & Industry Sponsors
- Technology Providers